Food web dynamics in the lower Columbia River estuary

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The BIG question

What factor or factors, if any, limit growth or survival of juvenile salmon in the Columbia estuary?

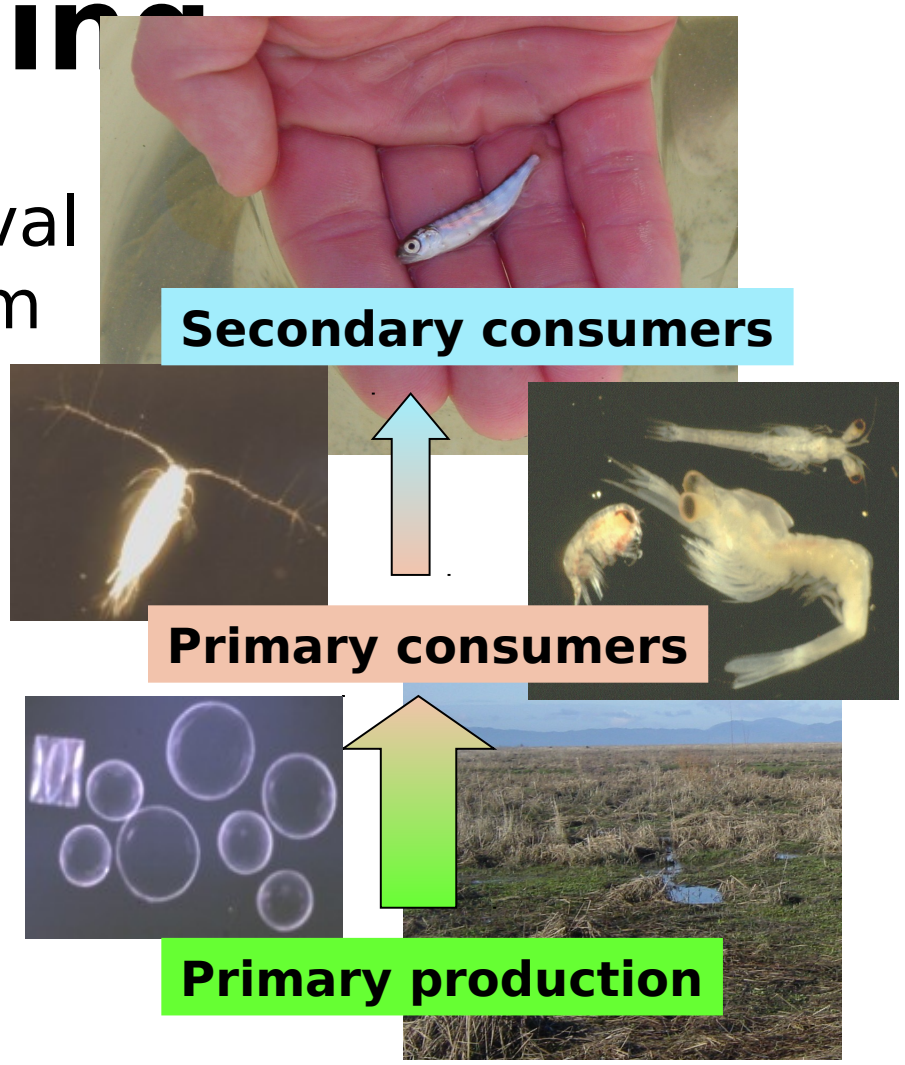
The “usual suspects…”

Habitat availability
Food availability
Predation
Disease & parasites

A food web approach: bottom-up & top-down forcing

Salmon growth & survival might be limited “from the bottom up”, by resource availability

- Food
- Primary production



A food web approach: bottom-up & top-down forcing

Salmon growth & survival might be limited “from the top down”, by mortality agents

- predators
- disease/parasites

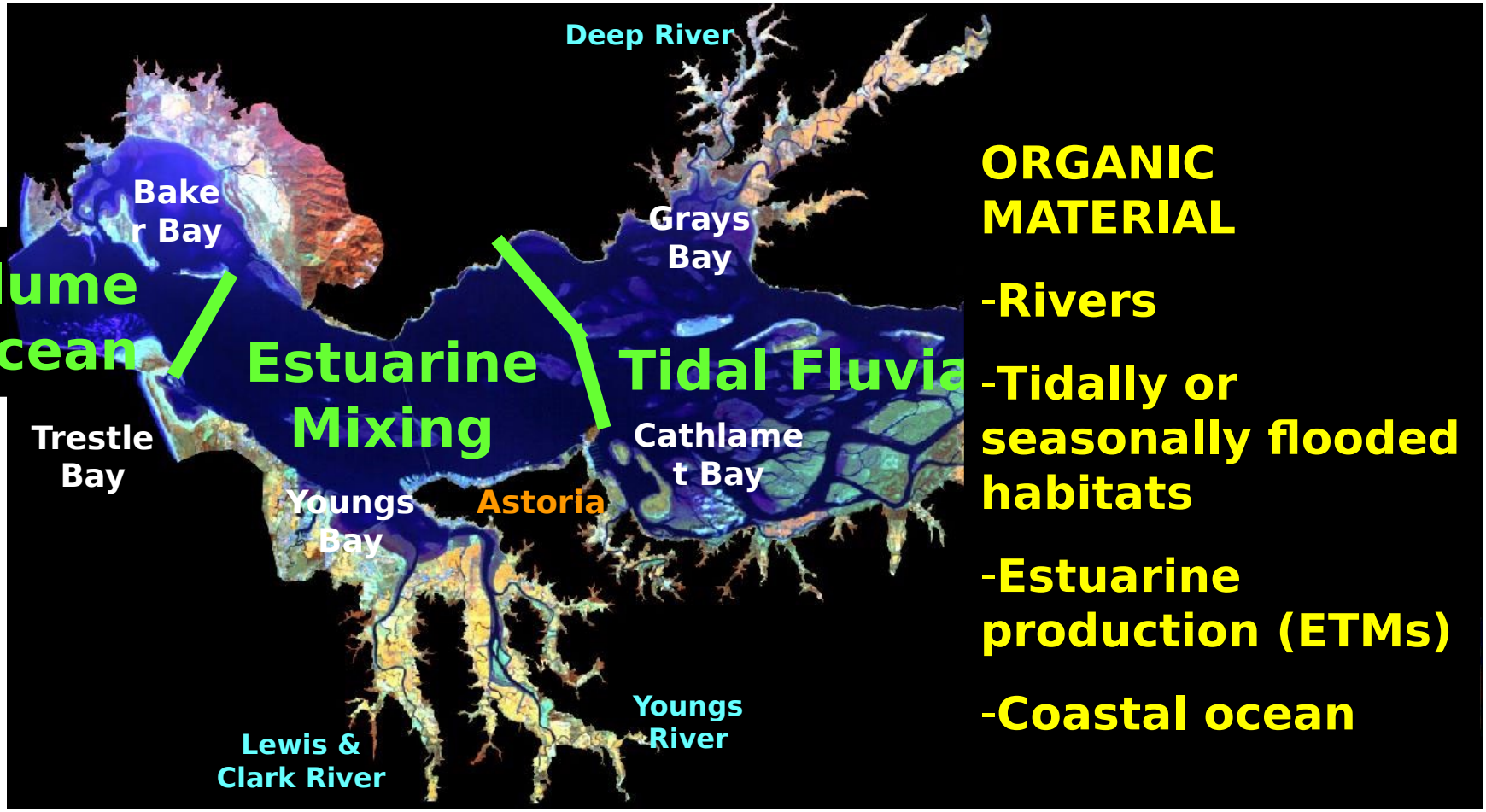
Upper trophic level consumers

Secondary consumers

Talk outline

- General background of the basis of food webs pathways in lower Columbia estuary
- Bottom-up factors
- Top-down factors
- Caveats, questions, challenges

Complex, dynamic structure



ORGANIC MATERIAL

-Rivers

-Tidally or seasonally flooded habitats

-Estuarine production (ETMs)

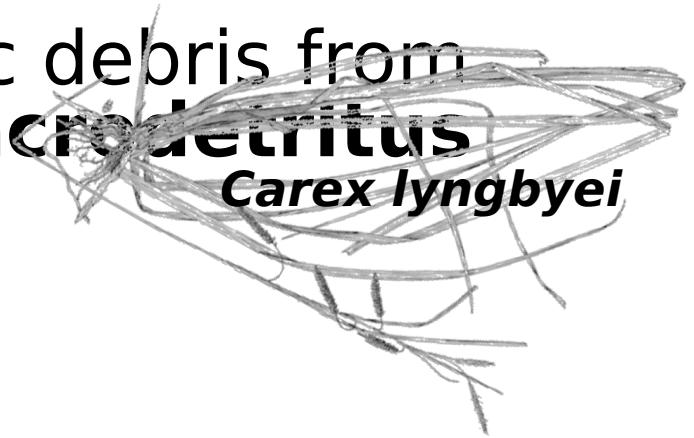
-Coastal ocean

Detritus-based production: microdetritus, macrodetritus

- Turbid water (photic depth <2.5 m), rapid flushing (2-5 days) limits primary production in water column

- When encountering saltwater, freshwater phytoplankton from upriver explode, die, & decompose, creating **microdetritus**

- Large, decomposing organic debris from wetlands, rivers creates **macrodetritus**



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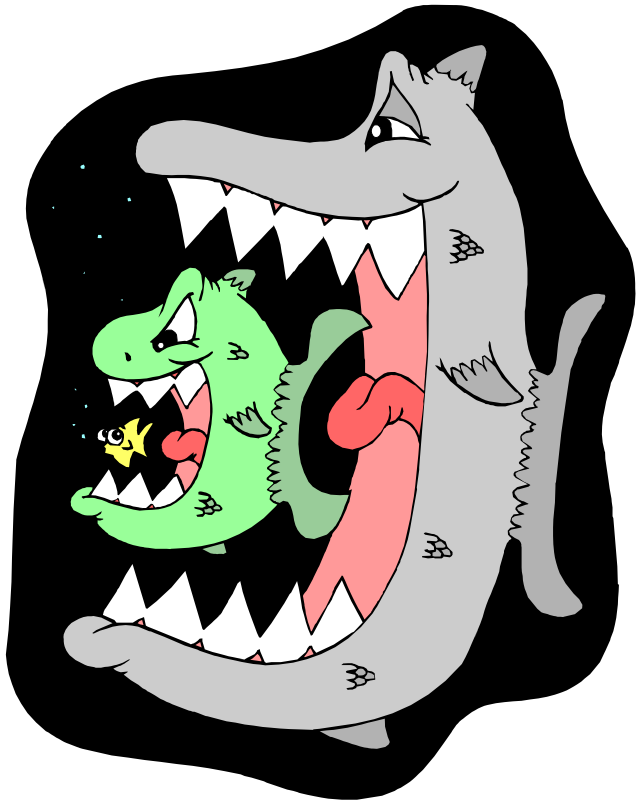
Relative importance of pathways leading to salmon???

- Macro- vs. microdetritus
- Terrestrial, riverine, estuarine, marine
- Acute, chronic pollution can enter food web pathways
- Invasive species can alter food web pathways



Salmon prey items: diverse, variable

- Strong links to benthic, detritus-based consumers
- Also links to insects, freshwater cladocerans, marine fish in lower estuary
- Salmon *probably* not prey-limited

Chironomid flies

Prey effects on condition, growth, survival???

- Relationships among habitat, prey quality, growth, energetics unresolved
- Causes for interannual variation in prey type, abundance not well understood
- Movement patterns of estuary-resident fish unresolved
- No information on relationship between use of/conditions in estuary, smolt-to-adult survival

Predation

- Fish predation likely unimportant: two of > 5,000 stomachs contained juvenile salmon
- During 1990s, birds removed 5%-17% of juvenile salmon in estuary, l
- Seal, sea lion predation in v

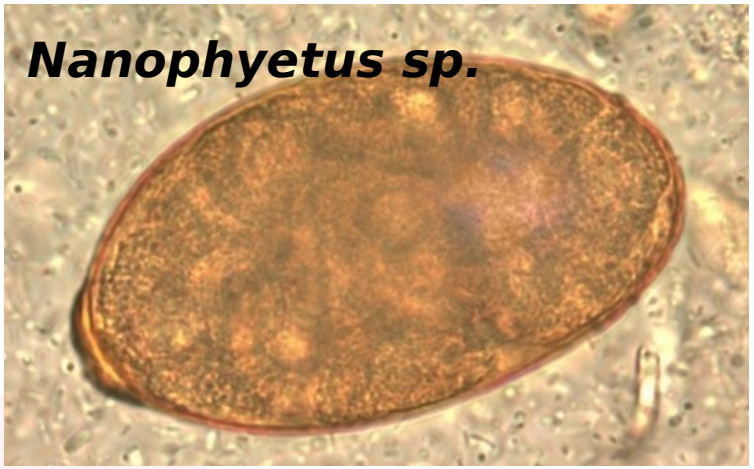
early stages of evaluation

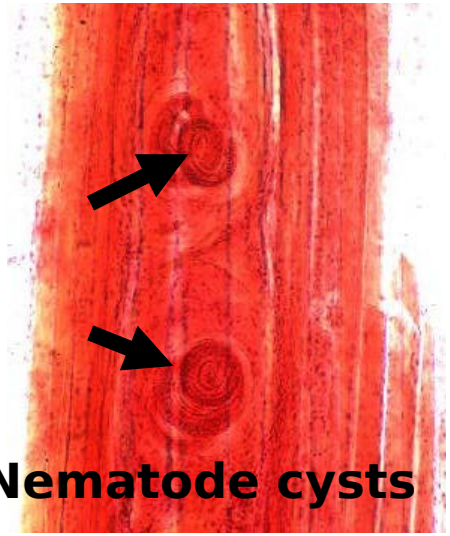
Caspian tern

Disease, parasites

- Work on disease, parasites in estuary began in 2001
- Sub-lethal, lethal freshwater organisms known

  to occur in estuary
- Ir





Relative mortality impacts???

"Salmon pie"

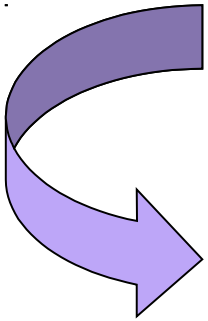
- Magnitude of total mortality in estuary unknown
- Relative proportions of total mortality due to different agents unknown
- Likely to vary year-to-year

Summary: present understanding

Bottom-up:

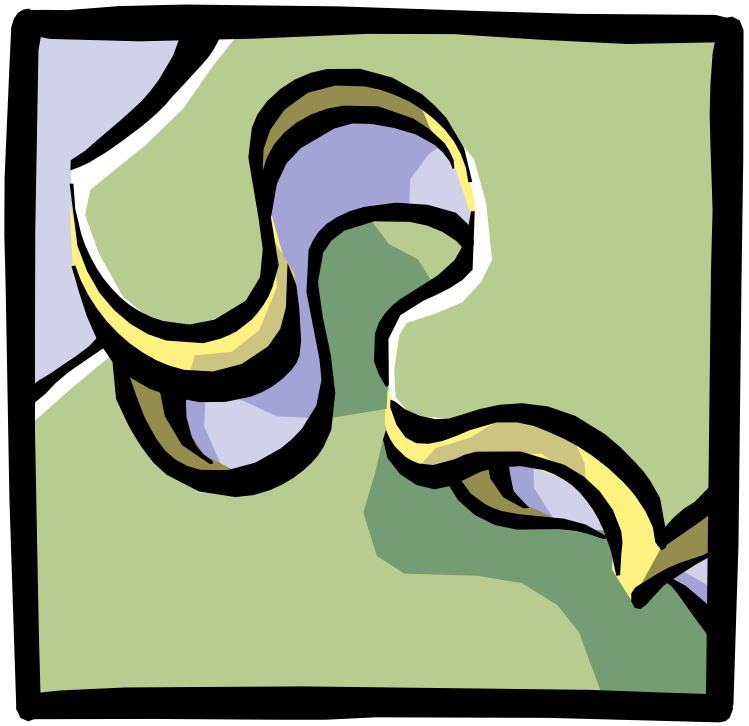
Salmon prey diverse, variable
Strong links to wetland, benthic macrodetritus
Links to freshwater plankton, insects, marine fish
Food availability not likely to be limiting

Top-down:



Fish predation on juvenile salmon unimpo
Bird predation significant, but decreasing
Marine mammals
Disease, parasites

A cautionary note

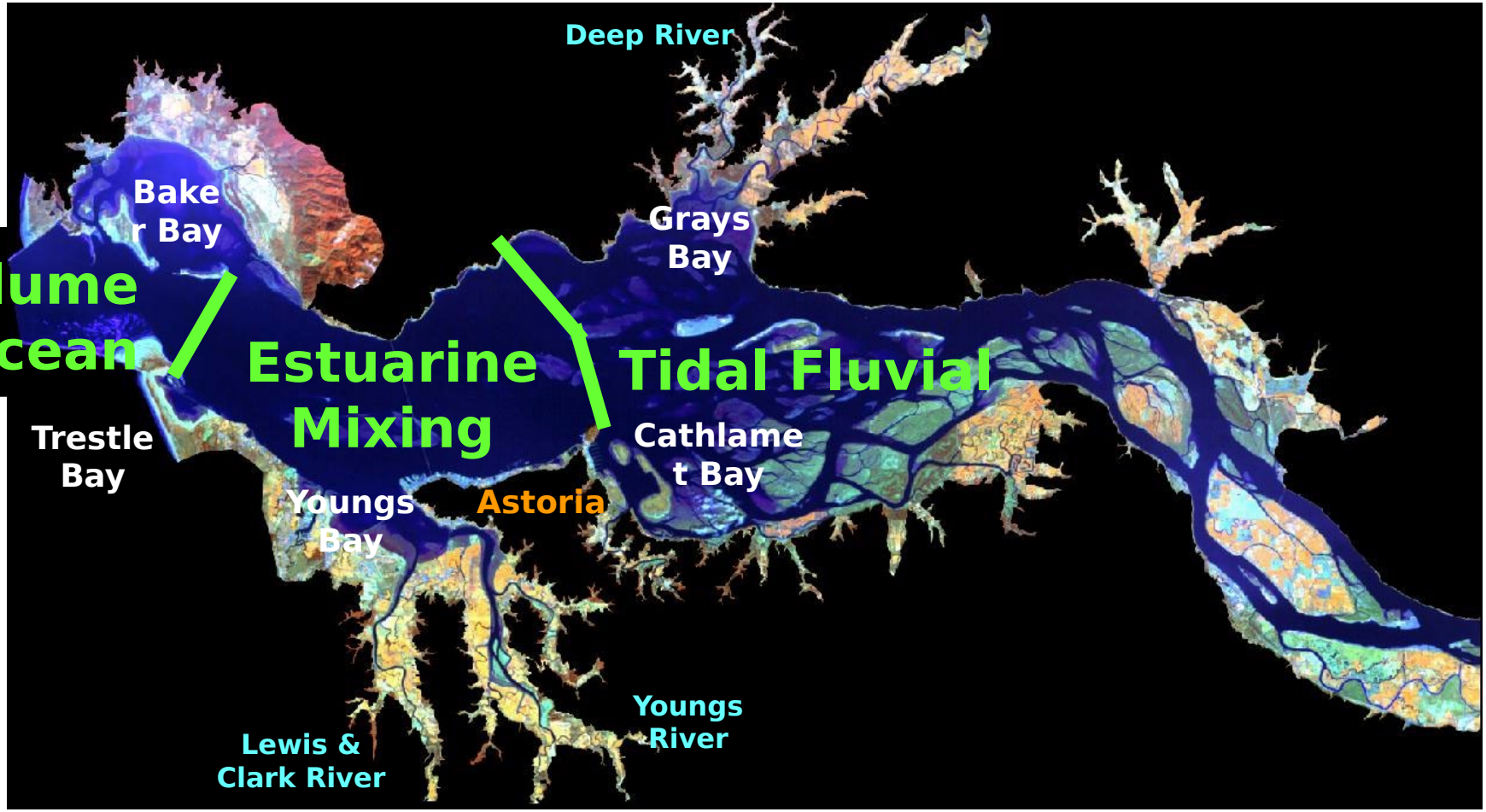


We have a framework --- but not the complete, up-to-date picture

Summary: what next

- Relative importance of different food web pathways leading to salmon
- Relationships among prey type, habitat vs. fish condition, growth, smolt-to-adult survival
- Resolve total magnitude, relative impacts of juvenile mortality agents
- Develop understanding of temporal variation in biological rate processes

Complex, *dynamic* structure



Columbia Challenge: temporal variability

- Dynamic, fluctuating environment
- Physics: higher resolution & precision, multiple time & space scales, remote data collection possible, robust interpolation, predictable
- Biology: lower resolution & precision, singular time & space scales, labor-intensive data collection/replication, interpolation difficult, interannual variation

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